FARM FACTS

Canada thistle and its control

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Canada thistle (Cirsium arvense) is a persistent perennial weed that causes significant crop yield losses. It reproduces through both seed and root regeneration, but the latter is the most successful. It stores food energy in its extensive root system both to survive the winter and to fuel the plant's reproductive drive the following season. Because of its contribution to the persistence of the weed, Canada thistle's extensive root system must be the target of an effective control program.

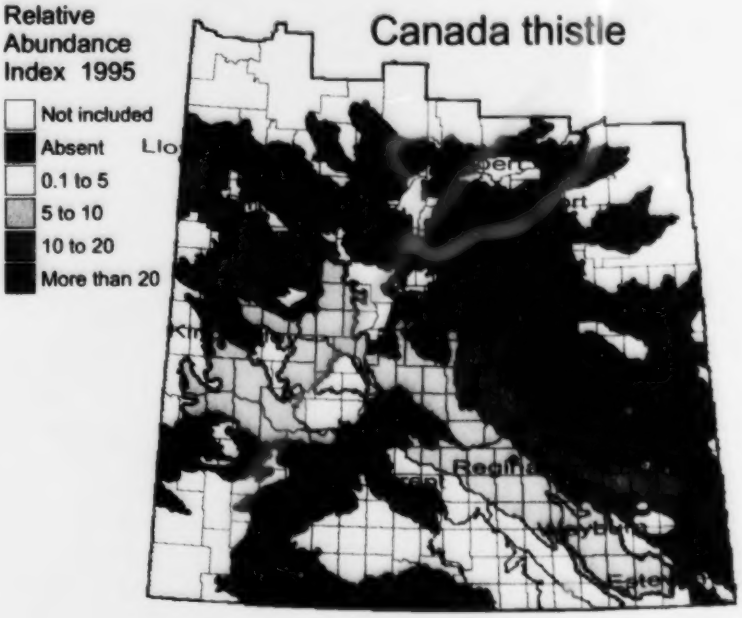
Background

The suspected origin of Canada thistle is the eastern Mediterranean region of Europe, and it was likely one of the first weeds imported to North America by early settlers. It gets the name Canada thistle since the early residents of New England (USA) blamed its appearance on the French traders from Canada, but historians now believe it arrived in both places at about the same time from Europe.

While Canada thistle is capable of inhabiting most of Saskatchewan, including the northern forest regions, it is best adapted to the high moisture crop production areas. In the 1995 Saskatchewan Weed Survey (Figure 1), Canada thistle ranked fifth overall, second in the Grey Wooded Soils and fourth in the Black Soils, in relative abundance. Although other weeds occur in higher densities Canada thistle is very competitive at low numbers (See Figure 2).

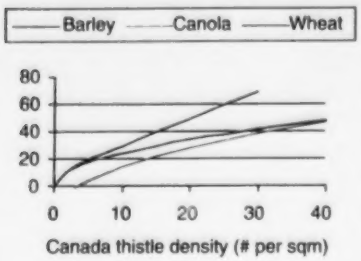
The weed grows most vigorously in land best suited to annual crop production, but will also inhabit roadsides, turf, gardens, wasteland, rail-beds, pastures, the margins of woodland areas, and at the edge of wetlands. Canada thistle does not tolerate very wet locations and needs direct sunlight in order to thrive.

Figure 1 **Canada thistle distribution from the Saskatchewan Weed Survey of Cereals, Oilseeds and Pulse Crops, 1995**



http://res.agr.ca/sask/sk95weedmp.html

Figure 2: Estimated yield losses from Canada thistle competition



Description

Canada thistle plants are from 1 to 5 feet (30 cm to 1.5 M) tall with several branches. Leaves are shiny, a deep green colour and arranged alternately on the stem and branches. Some biotypes have thin, flat leaves with short, fine spines, arranged sparsely around a slightly toothed edge, but most plants have leaves that are thick, leathery, with deep and irregular serrated margins and long sturdy spines. Stems have few, if any spines.

The majority of Canada thistle plants flower when day length is greater than 15 hours on average but the day length requirement can range from 14 to 16 hours. Canada thistle is unique to thistles in that individual plants have flowers that are either male or female, meaning that female and male plants need to be relatively close in order to produce seed. Female flower heads are generally vase shaped while those of the male are nearly round. Canada thistle flowers are very attractive to bees and other insects that are required for its pollination.

Figure 3: Canada thistle in flower

Photo by: F.A Holm - U of S

When pollination is successful, 1500 seeds per plant are produced on average, but production can be greater than 5000 per plant. Viable seeds can be present 8 to 10 days after flower emergence.

The seed is topped by a feathery tuft of hair called a pappus that is used by other plants as a means of transporting seed great distances from the mother plant. In Canada thistle however, this small "hang-glider" often drops its passenger close to the parent plant and many seeds never leave the seed head as their "glider" leaves without them.

Only a very small percentage of seeds travel a large distance from their origin. Most Canada thistle seed will remain viable for about 3 to 6 years when buried at typical tillage depth, but some seed may survive for up to 21 years.

Warm, moist soils (20 to 30°C) and full light are favoured for seed germination. Studies have shown that Canada thistle does not establish well from seed under highly competitive conditions, but once established it quickly becomes a problem weed due to its extensive root system.

Figure 4: Plants establish from either seed(top) or from root buds

Photo by: SAF

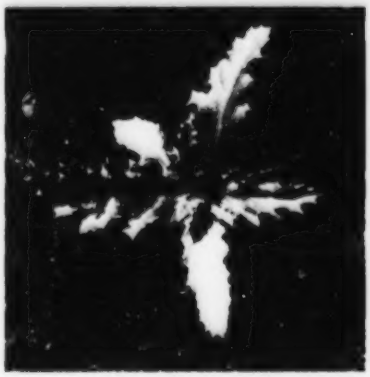


Photo by: F.A Holm - U of S

Roots

The thick, fleshy roots of Canada thistle make this weed difficult to control once established. The plant reproduces very successfully through vegetative "cloning" of itself from the root. Within 19 days of emergence (two-leaf stage) seedlings can regenerate after top-growth removal. During its establishment phase, Canada thistle initially produces a taproot that penetrates to

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depths in the soil with consistent moisture. Once moisture is found, lateral roots are produced that can extend as much as 20 ft (6 m) in a single season and produce a colony of genetically identical clones. Root depths of 6 to 10 ft. (2 to 3 m) are not uncommon and roots may go as deep as 18 ft (5.5 m).

Lateral roots are not only important for expanding the colony but also contribute to the spread of the weed vegetatively with the assistance of humans. New plants can be produced from root pieces as small as 1/8 to 1/4 of an inch (3 to 6 mm) thick and 3/8 of an inch (8 mm) long. Tillage and seeding implements contribute greatly to the vegetative spread of perennial weeds.

Since one Canada thistle plant needs to cross with another to produce seed, those plants that establish from seed generally exhibit a large amount of variability. But, because vegetative reproduction from the roots is much more successful than reproduction by seed, there are usually only a very few unique individuals in a field. The majority of the plants have established from root pieces.

Life Cycle

Understanding the life cycle of Canada thistle is important when developing strategies to control the weed. Since the success and spread of Canada thistle is as a result of its persistent root system, the root must be the target of a meaningful control effort.

Figure 5: Most seeds land close to the mother plant.

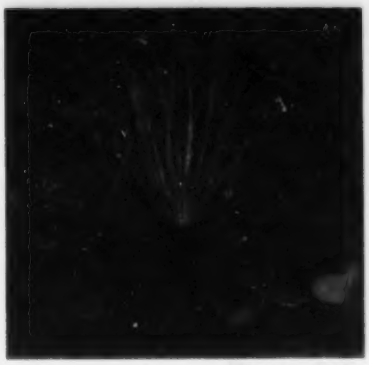

Photo by: SAF

As the soil temperature rises in the spring, buds on Canada thistle roots are stimulated to grow into new shoots. When new shoots emerge during late May and June, the long day-length triggers the immediate drive toward sexual reproduction and the energy reserves in the roots are the fuel for this process. Once the reproductive stage is complete the thistle plant switches to survival mode.

Shortening day lengths, which signal the approach of winter, trigger the movement of energy to the root for storage. Above ground parts produced by Canada thistle die back completely each winter and new shoots are produced from root buds in the spring. Old root tissue is continually being replaced by new, resulting in a particular root living only two years.

Cultural Controls

Before the development of herbicides, Canada thistle was controlled entirely with tillage. Weed experts in the 1930's believed that it was necessary to till intensively to prevent new foliage from recharging the root reserves. When an understanding was gained that Canada thistle will continue to draw from root reserves during the flowering period, strategies were revised to remove top-growth with either tillage or mowing, just prior to flower bud break. With this strategy, the number of passes can be reduced and still deplete root reserves.

Figure 6: The competitive ability of Canada thistle is visable in this wheat field.

Photo by: SAF

A drawback of a mechanical control system is the potential to move root pieces and increase the spread of Canada thistle within the field. If tillage is the only method of control used, a second year of top-growth removal may be necessary to starve the root completely. Another negative aspect of tillage as a control strategy is an increased risk of erosion from wind and water.

A way to achieve regular top-growth removal, while still providing both a source of income for the producer, and keep cover on the land for erosion control and organic matter management, is to grow competitive forages, particularly alfalfa or sweet clover, in the crop rotation. Several studies have shown that alfalfa hay in rotation can substantially reduce population densities of Canada thistle and other weed species within a three-year time frame.

Sanitation is an important part of any cultural weed control program. If cultivation is used it is important to work the infested area last and clean tillage implements prior to leaving the infested area.

Small Canada thistle flower heads are the same size as pea or lentil seed and can remain in the grain. Since viable seed is present soon after bud break, and often stays with the seed head, small flower heads and buds should be separated from grain to be used for seeding.

Chemical Control

An overview of herbicides registered for control of Canada thistle can be found in the *Guide to Crop Protection*, produced annually by Saskatchewan Agriculture and Food. Refer to this guide for additional information on crops, herbicide rates, relative cost, and other weeds controlled.

Many herbicides are only useful for top-growth control when used in the crop and will not hinder the long-term survivability of Canada thistle. Because of the growth inhibiting properties of Canada thistle and its residues, crop yield may still be depressed, even when thistle is controlled in crop with herbicides.

Systemic herbicides are usually most effective because they circulate through the entire Canada thistle plant including the root and therefore provide better long-term control.

Various techniques have been developed to maximize effectiveness of herbicide applications on Canada thistle. The *Bud Method* of control involves letting the thistle grow to the bud stage, when the plant is at a weak point in its life-cycle, then apply a systemic herbicide.

The ample foliage at this stage allows for good uptake and the circulation of sap carries the herbicide to the roots with the storage sugars. Rates of herbicides used at this stage tend to be higher than with the *Rosette Method*.

The *Rosette Method* of Canada thistle control combines the use of fallow tillage and a systemic herbicide. Tilling or mowing thistles in fallow (as described in "Cultural Control") will drain the root of more reserves than if the first flowering stem was left. New shoot growth emerging during periods when day-length is less than 15 hours will form a rosette and continue to produce food for storage in the roots. Assuming seven days

Table 1: **Herbicides Registered for Canada thistle control.**

Control	Top-Growth control	Suppression
amitrole (Amitrol 240) dicamba – (Banvel II in fallow) clopyralid - (Curtail M, Lontrel, FlaxMax Ultra, Prestige, Prevail) glyphosate – (Credit, Glyfos, Renegade, Roundup products, Touchdown products, Vantage products Victor) MCPB/MCPA (Clovitox, Tropotox) dichlobenil (Casoron in shelterbelts)	2,4-D bromoxynil/MCPA (Achieve Extra Gold, Buctril M, Platinum) dicamba (Banvel II (in-crop), DyVel, DyVel DS, Target) fluroxypyr/2,4-D (Attain) bentazon (Basagran) 2,4-DB (Calibre, Cobutox, Embutox) dichlorprop/2,4-D (Dichlorprop-D, Estaprop, Turboprop) tribenuron/2,4-D (Express Pack) glufosinate (Liberty) MCPA Mecoprop (Compitox, DyVel DS, Mecoprop, Target)	metsulfuron (Ally, Escort for pastures) thifensulfuron/tribenuron (Champion Extra, Champion Plus, Harmony Total, Refine Extra, Triumph Plus)

Control kills the plant and prevents regrowth for a substantial length of time. **Top-growth control** will kill the aerial parts of a plant but new shoots can grow from surviving secondary buds on the shoot or root. **Suppression** will not kill the plant directly but will prevent it from continuing to grow. This will allow a crop to gain a competitive advantage on the weed. Suppression can range from a delay in growth to preventing flowering to a complete arresting of the plant development for the remainder of the season.

for emergence of new shoots, the last tillage date before herbicide application may occur any time after the following dates to induce rosette formation:

- South of Regina - July 25,
- Regina to Saskatoon - July 29
- Saskatoon to Prince Albert - July 31
- North of Prince Albert - August 2.

Tillage operations should be to a depth of two inches. Wait four to six weeks after tillage to allow maximum rosette emergence before spraying with a systemic herbicide. Rosettes should be five to eight cm across at treatment. The herbicide is actively moved to the root in the sap, and the thistle plant is in a severely weakened state from the continued defoliation it has endured through the summer.

In northern agricultural regions of the Saskatchewan, fallow is less common and the risk of frost damage to thistle is high, before thistles reach prime application stage. These areas may be more suited to *Pre-Harvest* applications.

Pre-Harvest applications of glyphosate on registered crops can be used to control Canada thistle and other perennial weeds in most cropping systems. This application method has been found to be more consistent and up to twice as effective as applications made after harvest.

To minimize the uptake of glyphosate into the grain, applications are made prior to harvest when the seed moisture of the crop is at 30% or less (See the Table 2 for visual indicators of 30% seed moisture). Minimum Residue Limits (MRL) are placed on glyphosate content in harvested grain as a check for applications made prior to this stage. Do not use grain from areas treated with the *Pre-Harvest* method as seed for a new crop. Minute traces of glyphosate in the seed can severely reduce seedling emergence and vigour.

Canada thistle is very susceptible at this stage because it has a full growth of tender foliage to absorb the herbicide and the plant is actively moving reserves to the root.

Post-Harvest or *Fall Stubble* is an application window for systemic herbicides on Canada thistle that is often risky and inconsistent due to slow thistle growth and the risk of frost damage. Because most of the Canada thistle foliage is removed by harvest activities, a waiting period (up to six weeks) must be maintained to allow the plant to regenerate new leaves. Once the application is made, a frost-free period of two weeks is also needed to allow uptake and translocation of the herbicide to the root.

Canada thistle can survive a light frost and still be controlled with systemic herbicides, but heavy frosts will kill or damage top-growth and prevent the uptake of the herbicide. Gradual declines in temperature can condition plants to withstand lower temperatures.

A killing frost can only be confirmed by evaluating plants after waiting a day. Target leaves need to be green and supple to absorb herbicides. Leaves with a water- soaked, brittle, blackened, or browned appearance will not absorb the herbicides adequately to provide control.

Table 2: Visual Indicators of proper crop staging for *Pre-Harvest* glyphosate application.

CROP*	VISUAL SYMPTOMS
Wheat, Barley, Oat	Hard dough stage – a thumbnail impression remains on seed
Canola	Pods are green to yellow and most seeds are yellow to brown.
Flax (including Solin)	Majority (75 to 80% of bolls) are brown.
Lentil	Lowermost pods (bottom 15%) are brown and rattle when shaken.
Pea	Majority (75 to 80%) of pods are brown.
Dry Bean	Stems are green to brown in colour and pods are mature (yellow to brown) and 80 to 90% of the original leaves have dropped.
Forage	3 to 7 days prior to the last cut before rotation or forage renovation. **Do not apply to forage stands that are to be maintained.**

Herbicides

Clopyralid is the active ingredient for many herbicide products with very good activity on Canada thistle and are suitable for use in wheat, barley, canola and flax. Clopyralid is a plant hormone mimic (Group 4) that causes twisting symptoms. Soil residues can persist into the year following application, and may damage sensitive crops, particularly legumes. Users should follow recropping recommendations very carefully to avoid damage to pulse crops and legume forages. Studies have shown that clopyralid will translocate more readily in that period when the Canada thistle is moving storage materials to the roots for winter, but is also very effective at the early bud stage in crop. When applied in the fall, control with clopyralid can be maintained into the following season.

Research has shown that an in-crop application of clopyralid followed by a *Pre-Harvest* glyphosate can provide about 85% control verses the average 70% control for either single product. Producers should evaluate the potential return expected for the crop to follow (Figure 2) against the cost for the additional herbicide and application.

Picloram is related to clopyralid but is less flexible due to its longevity in the soil, the sensitivity of many broadleaf crops, and the potential for ground water contamination and movement. Its use on cropland is restricted to spot treatment for perennial control, but is a suitable product for use in pastures with medium to heavy textured soil.

Glyphosate is a non-selective herbicide (Group 9) that is used for control of many perennial weeds including Canada thistle. Symptoms are slow to appear and begin as yellowing of new growth that spreads through the entire plant. It is very short lived in the soil and therefore can be applied without recropping concerns. It can be used in fallow, after harvest, or *Pre-Harvest* to control Canada thistle.

Some products may also be used for season long control of Canada thistle in glyphosate tolerant crops. Glyphosate can be used with the *Bud Method* or *Post-Harvest* at 1.9 to 2.8 L per acre (4.75 to 7 L per ha) and with the *Rosette Method* or *Pre-Harvest* at 1.0 L per acre (2.5 L per ha). Glyphosate at 0.69 L per acre may also be used in combination with Banvel at 0.5 L per acre with the *Bud Method* and *Post-Harvest* method of thistle control that is as effective as the higher rates of glyphosate alone. Rates of use are for 356-360 g/L formulations only. Check the Guide to Crop Protection for rates of other formulations.

Dicamba is a plant hormone mimic (Group 4) and causes twisting symptoms. When dicamba or its mixes are used at rates safe to registered crops, it provides only top-growth control. Rates of Banvel II (dicamba) for Canada thistle control may be applied in summer fallow but injury will result at these rates, if used in cereal crop. Banvel II can be used with the *Bud Method* at 1.0 L per acre (2.5 L per ha) or with the *Rosette Method* at 0.5 L per acre.

In some situations applications made at the higher rate and later in the fallow year may lead to recropping restrictions the following year.

Amitrole (Group 11) is registered for control of Canada thistle in fallow or after harvest at a rate of 5.0 to 6.6 L per acre (12.4 to 16.3 L per ha). Amitrole inhibits the production of pigments, including chlorophyll, to essentially starve the plant. There are some concerns about soil persistence with higher rates of Amitrole.

Biological control

Biological control of a weed is the use of predators or diseases that will attack the weed and reduce its impact. Classical biocontrol involves importing organisms from the weed's place of origin and releasing it on the weed.

Intensive screening is done to insure that biocontrol will not effect plants other than their target. Several insects have

been released in Canada on Canada thistle. These insects are the stem gall fly, *Urophora cardui,* the stem weevil, *eutorhynchus litura*, the defoliating beetle, *Lema cyanella.*

It has been difficult to find biological control agents for Canada thistle since they either fail to survive or are not specific enough to Canada thistle to release.

The seed head weevil *Rhinocyllus conicus,* originally released on nodding thistle, will also attack Canada thistle. Insects that were accidentially introduced to Canada that also attack Canada thistle. These are the seed-head fly, *Terellia ruficauda* and a small midge with yellow-orange larvae *Dasineura gibsoni* that feed on the pappus.

The paintedlady butterfly larva *Vanessa cardui* is a native migratory insect that prefers feeding on Canada thistle. It will feed on other plants including some broadleaf crops, making it unsuitable for biocontrol.

Inundative biological control uses specific plant pathogens that exist in the local environment that will infect a weed. Pathogens are increased through fermentation, and are applied in great numbers as a bio-herbicide. After application, these organisms return quickly to their normal level in the soil. Organisms of this type are under investigation at Agriculture and Agri-Food Canada in Saskatoon. There are no products of this type on the market at present.

Conclusions

Canada thistle is a difficult weed to control because of its extensive perennial root system. Because Canada thistle causes yield loses at relatively low numbers, keeping it in check can provide substantial economic benefit. A long-term plan that combines a number of the above tools and techniques over a number of years is needed to bring the weed under control.

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